Factors associated with uptake of vaccination against pandemic influenza

Scientific Evidence Base Review

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Contact Details	Dr John Connolly Pandemic Influenza Preparedness Team Department of Health Skipton House, 80 London Road London, SE1 6LH (020) 7972 5303
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Scientific Evidence Base Review

Prepared by Dr Alison Bish, Professor Susan Michie (University College London) and Professor Lucy Yardley (University of Southampton). Valuable advice and suggestions were also received from Professor Angus Nicoll CBE (Senior Expert – Influenza Coordination, European Centre for Disease Prevention and Control) and Dr James Rubin (NIHR Career Development Fellow, Kings College London).

This review was commissioned by the Department of Health in October 2010. The document was subsequently reviewed and endorsed by the Scientific Pandemic Influenza Advisory Committee (SPI).

It is anticipated that additional informative studies in this area will be published over the course of 2011 and 2012. The review will therefore be updated periodically to reflect any additions to the scientific literature that might alter any of its conclusions.

Contents

Executive summary

Background

Vaccination programmes for H1N1 influenza were introduced between September and December 2009. Evidence from behavioural science sheds light on why an individual may or may not choose to be vaccinated. Understanding factors that affect uptake of vaccination informs the development of interventions to increase vaccination in target populations. Yet the vast majority of research funding over the past decade has been devoted to biomedical topics rather than to social and behavioural science.

Data will soon be published from a study conducted by VENICE-ECDC (The Vaccine European New Integrated Collaboration Effort and European Centre for Disease Prevention and Control) showing coverage for vaccination against H1N1 influenza in 26 European Union Countries and two European Economic Area countries. Preliminary findings were recently presented at a conference (Mereckiene 2010) and are described here. When the final validated figures from this study are available, this report should be updated.

Objectives

To investigate (a) the uptake of vaccination against the 2009 H1N1 influenza and the likely future uptake of pandemic or pre-pandemic vaccination (b) the demographic and psychological predictors of intentions and uptake of H5N1 and H1N1 influenza vaccination (c) evidence for interventions and communication strategies to effectively tackle barriers to, and increase informed uptake of, vaccination.

Five population groups are considered: health care professionals, people in clinical risk groups, pregnant women, general population, and parents (regarding vaccination of their children).

Method

A systematic review of the published literature to 21 October 2010 searched for studies of reported rates of intentions to be vaccinated against pandemic influenza or actual uptake of vaccination and studies which included associations between demographic characteristics, attitudes and reported intentions or behaviour, published in English. Identified papers were sifted for relevance by title, abstract and full text. Official rates of uptake of vaccination were

obtained from a Health Protection Agency Report (for the UK), a VENICE-ECDC conference presentation (for EU and EEA countries) the Centers for Disease Control and Prevention (for USA) and the Australian Institute of Health and Welfare (for Australia). References were additionally obtained from an expert panel of the Behaviour and Communications sub-group of the UK Scientific Pandemic Influenza Advisory Group. This was particularly informative for the communications and interventions section of the report. Due to the heterogeneity of identified studies, a narrative approach was adopted for data synthesis.

Results

3,906 articles were identified, 31 of which met the study inclusion criteria. Five were subsequently excluded as being of low value due to having unrepresentative samples and one was excluded as the data were repeated in a later, more detailed, article, leaving a total of 25. Eighteen concerned factors associated with uptake of H1N1 vaccination, three with uptake of H1N1 and seasonal influenza vaccination and three with uptake of pre-pandemic vaccination. No intervention studies to increase uptake of H1N1 vaccination were identified; one study investigated reasons for parents to reject H1N1 vaccination for their children. Consequently, although not part of the systematic review, this report also considers two reviews of interventions to improve seasonal flu vaccination.

Evidence from many countries suggests that rates of vaccination against H1N1 influenza are sub-optimal amongst health professionals, clinical risk groups, pregnant women, general population and children. For all groups rates of intentions to be vaccinated against H1N1 influenza tend to be higher than actual uptake of vaccination.

Intentions to be vaccinated tended to change over time with studies carried out in the autumn of 2009 showing lower rates than earlier studies, more comparable to the subsequent uptake of vaccination.

The evidence from the review suggests the following likely explanations for the low intentions and uptake: a perceived lack of susceptibility to developing H1N1 influenza, low levels of concern and worry about the disease and concerns about the safety of the vaccine and its side effects. This is in the context of the 2009 pandemic where there was a discrepancy between public perceptions of the predicted severity of the pandemic and its ultimate relatively mild manifestation, and considerable discussion in the media about the safety of the vaccine. There was evidence that having been vaccinated in the past against seasonal influenza may increase

future uptake of vaccination against pandemic influenza. In addition, organisational factors may have played a role in the rates of coverage in some countries.

Evidence from studies of uptake of non-pandemic influenza vaccination indicate that interventions likely to be effective include those which communicate the risks posed by pandemic influenza, highlight the benefits of vaccination and address any safety concerns. Strategies to do this include highlighting the risk posed by pandemic influenza whilst simultaneously offering tactics to ameliorate this risk (e.g. vaccination). The perceived costs of vaccination can be tackled by reducing the omission bias (a perception that harm caused by action is worse than harm caused by inaction) in order to help to ameliorate safety concerns. In addition, interventions to increase seasonal influenza vaccination in advance of a future pandemic may be an effective strategy to achieve high rates of vaccination against influenza during a pandemic.

Conclusion

The evidence suggests that in some countries rates of vaccination against pandemic influenza will fall far short of targets. This review has highlighted psychological factors which are associated with intentions and uptake of vaccination. It is possible now, in advance of a pandemic, to develop and implement interventions designed to increase vaccination rates. These should target uptake of seasonal influenza vaccination and also perceptions of risk and beliefs about the efficacy and safety of pandemic influenza vaccinations.

1. Background

Vaccination programmes for H1N1 influenza were introduced between September and December 2009 in 45 countries (see Appendix 2 for full list). Different vaccination policies operated in different countries, some aimed to vaccinate the entire population whereas others targeted vaccination at particular groups (children, people with chronic disease, pregnant women).

It is important to understand factors that affect uptake of vaccination, in order to be able to develop interventions to tackle any shortfall in vaccination of the target population. Evidence from behavioural science sheds light on why an individual may or may not choose to be vaccinated and can inform the development of such interventions. A sub-optimal[1] vaccine programme has large financial implications. For example, in the UK £1.2 billion was spent on 29 million vaccines and also on antivirals and antibiotics; 20 million doses of vaccine were ultimately not used (Hine 2010). Yet "*over the past decade more than 95% of funding [for influenza and influenza vaccination] has been devoted to biomedical topics rather than to social and behavioral science. Clearly, cutting-edge laboratory science to enhance the safety and effectiveness of vaccines is vital to public health. But it is equally important to understand the forces that shape public views about the risks and benefits of vaccination. Without this knowledge, it will be impossible to translate biomedical advances into effective action.*" (Harris, Maurer et al. 2010).

This paper addresses the following questions:

- What was the uptake of vaccination against the 2009 H1N1 influenza and what is the likely future uptake of pandemic or pre-pandemic vaccination?
- What are the predictors of intentions and uptake of H5N1 and H1N1 influenza vaccination?
- What evidence is there for interventions and communication strategies to effectively tackle barriers to, and increase informed uptake of, vaccination?

Data will soon be published from a joint VENICE-ECDC (The Vaccine European New Integrated Collaboration Effort and European Centre for Disease Prevention and Control) study showing coverage by risk and target group for vaccination against H1N1 influenza in 27

European Union countries and 2 European Economic Area countries (Norway and Ireland). Preliminary findings from this study were recently presented at the European Scientific Conference on Applied Infectious Disease Epidemiology (Mereckiene 2010) and are described here. However, these are not the final figures for vaccination coverage and in order to get a complete picture of vaccination uptake against H1N1 influenza the results presented here should be supplemented with the validated data from this study. These results will be available early next year. It is therefore recommended that this report is updated at that time.

There are five population groups to consider (not mutually exclusive) –

(a) health care professionals
(b) people in clinical risk groups
(c) pregnant women
(d) general public
(e) parents – vaccination of their children

Health Care Professionals are a key group in that extensive vaccination of health professionals would have the following benefits:

- protect patients from infection
- prevent infection from patients
- protect the families of health professionals from infection acquired as a consequence of work
- reduce disruption to services as health care professionals are needed to treat and care for patients as usual.

Health professionals are an important influence on population attitudes and behaviour in terms of health care. A study involving 3,917 adults from the USA found that those citing health care providers as their source of information were more likely to perceive influenza to be serious and the vaccination to be efficacious and safe (Maurer, Uscher-Pines et al. 2010). Results from the European Vaccine Safety Attitudes training and Communications Project (VATSACT) show that health professionals were indicated as the most important and trusted source of information on childhood vaccination (Stefanoff, Mamelund et al. 2010). There is a concern that if the majority of health professionals report that they do not intend to have a vaccination

[1] **Optimal uptake for the vaccine programmes refers to 100% coverage in the targeted groups in order to reduce morbidity and mortality. See Section 4 for a discussion of whether this should be the aim of a programme.**

against H1N1 influenza themselves, they may be reluctant to recommend it to their patients. Indeed a study carried out in Canada with 921 family physicians and paediatricians found that the strongest predictor of intention to recommend the H1N1 vaccine to patients was the health professional's own intention to be vaccinated (Dube, Gilca et al. 2010). Given that health professionals are important role models, the general public may be reluctant to be vaccinated if they see that health professionals are not being vaccinated.

The research evidence reviewed below should be viewed in the context of the changing perception of the 2009 H1N1 pandemic during its course. The studies were carried out at different times during (or before) the pandemic and most had short data collection periods and therefore provide a snapshot of intentions and attitudes at a particular time. For example, a large UK study of randomly sampled general population (Rubin, Potts et al. 2010) showed fluctuation in levels of worry about H1N1 influenza. From initially low levels during May 2009, levels increased in mid-June after the full pandemic had been declared, and there was a second peak in levels of worry in July 2009 at the height of the summer outbreak. Levels of worry remained lower and more stable following the spring-summer influenza wave (from the end of August onwards) when experts and governments officially started to acknowledge that the pandemic was mild. Smaller increases coinciding with the start of the autumn-winter wave of the outbreak and the start of the vaccination campaign were observed. This study showed that levels of worry were strongly associated with intentions to be vaccinated and such perceptions could influence levels of uptake of vaccination. Indeed, it was observed in Canada, Romania, Finland and the Netherlands that publicity surrounding the death of a well young person from pandemic flu led to a sudden upsurge in vaccination (Prof Angus Nicoll, personal communication).

Comparisons of data across studies need to recognise the many differences in contexts. For example, countries showed different epidemic curves so comparisons across time are not straightforward. Countries also vary in availability of vaccination, so that data about intention may mean very different things in different countries. In most countries vaccination against H1N1 was offered to clinical risk groups (people with chronic conditions, young children, and pregnant women) and health professionals only. Whilst uptake data are for these groups, data on intentions are on a wider sample.

The primary purpose of this review was to describe rates of uptake and intentions to be vaccinated against pandemic influenza, either before a pandemic or during one, in countries offering vaccination against a particular strain of influenza. In addition the review sought to highlight factors associated with these intentions and behaviour. Such information can be used to inform targets for interventions in order to increase informed uptake of vaccination before or during a future pandemic.

2. Methods

This review is of studies of vaccination against pandemic influenza and pre-pandemic influenza with representative study samples. Studies of uptake of seasonal influenza vaccination are not included, since it is usually offered to somewhat different groups and under different circumstances – i.e. routinely every year in a non-emergency situation. However, since being vaccinated against seasonal flu can predict uptake of pandemic influenza vaccination (see evidence below) and the pattern and predictors of uptake appear to be similar (Rubin, Potts et al. 2010), two reviews of interventions to increase seasonal flu vaccination are included. The inclusion and exclusion criteria for the review are as follows:

Inclusion

(1) Population: health care professionals, general population, pregnant women, clinical risk groups or parents (not mutually exclusive)

(2) Behaviour: intentions to have, or uptake of, a pre-pandemic vaccination or a pandemic vaccination

(3) Psychological variables and demographic characteristics had to be included and associations between these and behaviours (intended or actual behaviour) reported.

(4) Date: no restriction

(5) Language: published in the English language.

Exclusion

(1) Type of study: Editorial, letter (unless providing data), mathematical modelling study, studies about medical efficacy of vaccination, no demographic or attitudinal data.

(2) Language: non-English

(3) Behaviour: solely about rates of uptake of vaccination against seasonal influenza with no intervention data.

Search Strategy

Web of Science and PubMed were searched on 20 and 21 October 2010 with no time period restrictions. Appendix 1 gives details of the search terms used.

Other Sources

Official rates of uptake of vaccination were obtained from a Health Protection Agency Report (for the UK), a VENICE-ECDC presentation at the European Scientific Conference on Applied Infectious Disease Epidemiology (for EU and EEA countries) the Center for Disease Control and Prevention (for USA) and the Australian Institute of Health and Welfare (for Australia). The reference lists of the references were searched for additional relevant studies. References were also obtained from an expert panel of the Behaviour and Communications sub-group of the UK Scientific Pandemic Influenza Advisory Group. This was particularly informative for the communications and interventions section of the report.

Study selection and data extraction

The titles of all papers identified by the searches were scanned. Some were excluded at this point for not being relevant or for being duplications. Abstracts of the papers which seemed to meet the inclusion criteria were read. Full text papers were obtained for those which were relevant or for those where further clarification of relevance was needed (e.g. if the abstract was very brief).

The following data were extracted for each paper: author & date of publication, country of study; type of vaccination; study design; time point of data collection; sample characteristics; theoretical model used; results.

Quality assessment

Studies with unrepresentative samples were excluded once full text of the papers had been read.

Data synthesis

The data synthesis involved a narrative approach, summarising rates of intentions and behaviour across countries and time periods.

3. Results

The search identified 3,906 papers. These were firstly reviewed on the basis of title and those judged to be irrelevant and duplicates were excluded. Abstracts of the remaining papers were read and further exclusions carried out. If no abstract was available the full text of the paper was sought in order to judge its relevance. Full texts of the remaining papers were read and 31 were retained as meeting the study inclusion criteria. Five were subsequently excluded as being of low value due to having unrepresentative samples (Tozzi, Gesualdo et al. 2009; Ferguson, Ferguson et al. 2010; Rachiotis, Mouchtouri et al. 2010; Thoon and Chong 2010; White, Petersen et al. 2010) and one excluded as the data were repeated in a later, more detailed, paper (Lau, Yeung et al. 2009). Eighteen concerned uptake of H1N1 vaccination, three concerned H1N1 and seasonal influenza vaccination and three were about pre-pandemic vaccination (see table 2). No intervention studies to increase uptake of H1N1 vaccination were identified; one study investigated reasons for parents to reject H1N1 vaccination for their children (Brown, Kroll et al. 2010), and this was included. Given the lack of intervention studies to improve uptake of vaccination against pandemic influenza, two reviews of interventions to improve seasonal flu vaccination were also considered. The studies providing evidence of demographic and psychological variables associated with vaccination uptake were from the UK, USA, Canada, Australia, France, Spain, Italy, Greece, Turkey, Hong Kong, Mexico and Malaysia. However, more countries than this implemented a vaccination programme against H1N1 influenza.

The review results will be considered separately for health professionals, clinical risk groups, pregnant women, the general public and parents. Rates of reported intentions to undergo vaccination (or have children vaccinated) and uptake of vaccination against H1N1 are considered for each group, followed by evidence of demographic and attitudinal factors associated with these intentions and behaviour.

It is important to note here a caveat that many of the studies identified by the review have examined reported **intentions** to be vaccinated, rather than the **behaviour of being vaccinated.** Some psychological models of health behaviour suggest that the proximal determinant of a behaviour is an intention to perform it (e.g. Theory of Planned Behaviour, Ajzen 1991). Intentions are a necessary although by no means sufficient precursor of

behaviour. If intentions are sub-optimal behaviour is also bound to be – i.e. they put an upper bound on likely behaviour and are therefore useful indicators. However, those studies examining intentions have the limitation of the 'intention–behaviour gap' where intentions may not translate into behaviour (Orbell and Sheeran 1998). A study carried out in the USA involving 1,527 people found that 50% of those who intended to be vaccinated (against seasonal influenza) did not attend for a vaccination. In contrast only 2% of those who said they did not intend to be vaccinated actually did get a vaccination (Harris, Maurer et al. 2009). This 2% highlights the importance of intentions in their own right as an essential precursor to behaviour. The mismatch between intentions and subsequent behaviour may be because intentions are unstable and influenced by changing circumstances and situations and/or that unforeseen barriers occur to prevent people acting on their intentions. Intentions assessed in the studies below are mainly assessed when the vaccine is not available to the individual and therefore they are responding to a largely hypothetical situation. With an infrequent behaviour such as vaccination there is more opportunity for barriers to occur than with a frequent behaviour such as physical activity. Research has shown that both intention stability and barriers can moderate the relationship between intention and behaviour (DiBonaventura and Chapman 2005).

Vaccine intentions and uptake

Table 1 shows rates of intentions and uptake of vaccination at different time points in the pandemic amongst health professionals, pregnant women, those at clinical risk, children and the general population. It shows that there is geographical variation and how on the whole intentions to be vaccinated decreased as the pandemic progressed, whereas conversely vaccination rates tended to increase.

Vaccination intentions and uptake amongst health professionals

Intentions to have a pre-pandemic vaccination: health professionals

A cross sectional study carried out in Hong Kong during the early stages of the 2009 H1N1 pandemic (April 2009), found that only 28.4% of the 2,255 health care workers surveyed were willing to accept a pre-pandemic H5N1 vaccine (i.e. a vaccine against a pandemic

Table 1: Rates of intentions and uptake of H1N1 vaccination over the course of the pandemic

Date *(vaccination start dates in countries)*	Health Professionals	Pregnant women	Clinical risk	Children	General Population
April 2009	47.9% intention (Hong Kong, Chor et al 2010)				
May 2009					49.6% intention (USA, Maurer et al, 2009) May-June
June 2009	80% intention (Mexico, Esteves-Jaramillo et al, 2009) June-September			65% intention to vaccinate children (France, Setbon & Raude, 2010) June-July	61% intention (France, Setbon & Raude, 2010) June-July
July 2009					45% intention reducing to 15% or 5% with cost or safety issues (Hong Kong, Lau et al 2010)
August 2009	77% intention GP, 88% paediatrician (Canada, Dube et al 2010) Aug-Sept 69% intention (Canada, Kaboli et al 2010) Aug-Sept				56% intention (UK, Rubin et al, 2010) August-September. 67% intention (Australia, Eastwood et al, 2010) 65% intention (USA, Horney et al 2010) 53% reducing to 37% intention by end of study (Greece, Sypsa et al 2009) Aug-Oct
September 2009 *Australia starts vaccination for adults and children over 10 years old*	62% intention (France, Schwarzinger et al 2010) 52.4%-55.6% intention (UK, Rubin et al in press)			60%-75% intention to have children vaccinated (UK, Rubin et al, in press)	54% intention (Australia, Seale et al 2010)
October 2009 *UK, Italy, France, USA and Canada start vaccination*	30% intention women; 49% intention men (Italy, La Torre et al, 2010) Oct-Nov 21.8% intention (Greece, Maltezou et al, 2010) Oct-Nov				70% intention (Malaysia, Wong and Sam, 2010) Oct-Dec
November 2009 *Greece, Spain and Turkey start vaccination*	**14% vaccinated (Italy, La Torre et al, 2010)** **12.5% vaccinated (Turkey, Savas et al, 2010) Nov-Dec**	**37.9% (France, Schwarzinger et al, 2010)**	**34.8% (France, Schwarzinger et al, 2010)**	21% intention to have children vaccinated (France, Schwarzinger et al, 2010)	15% intention (France, Schwarzinger et al, 2010) **1.9% (France, Schwarzinger et al, 2010)**
December 2009 *Australia starts vaccination for*	**16.5% vaccinated (Spain, Virseda et al, 2010) Dec-Jan**		**25% vaccinated (USA, CDC)**	**37% of children vaccinated (USA, CDC)**	**20% of adults vaccinated overall: 22% in over 65s and 14% in 25-65 years old (USA, CDC)**

children 6 months – 9 years old					**19% of adults vaccinated overall: 42% in over 65s and 14% in under 65s (Australia, Australian Institute of Health and Welfare)**
To March 2010	**40%-55% vaccinated (UK, McClean and Peabody 2010) 37% vaccinated (USA)**	**57% (Ireland, McClean and Peabody 2010)**	**37%-86.5% vaccinated (UK, McClean and Peabody 2010)**	**23.6%-44.6%% children 6mths – 5 years vaccinated (UK, McClean and Peabody 2010)**	**20% vaccinated (USA, Maurer et al, 2010)**
To August 2010	**70% Hungary, 50% Romania and Netherlands, 15% Italy, 12% Spain <10% Czech Republic (Mereckiene, 2010)**	**60% Netherlands, 12% Italy, <10% Spain, Hungary, Estonia, Slovenia, Czech Republic (Mereckiene, 2010)**	**75% Netherlands, 20% Spain, Estonia and Denmark, 12% Italy, 8% Luxembourg (Mereckiene, 2010)**	**80% Netherlands, 60% Norway, 50% Ireland and Iceland, <10% Luxembourg, Slovenia and Italy (Mereckiene, 2010)**	**60% Sweden, 50% Finland, Norway, Iceland, <10% Germany, France, Luxembourg, Portugal, Slovenia, Italy, Estonia, Greece, Cyprus, Austria and Czech Republic (Mereckiene, 2010)**

The data collection periods are shown for those studies which lasted more than one month (e.g. June-July).
Uptake rates for vaccination are written in **bold**

strain of avian influenza) and this did not rise when the World Health Organisation raised its pandemic alert level to phase 5 (Chor, Ngai et al. 2009). The willingness to accept pre-pandemic H1N1 vaccine (i.e. a vaccine against *the current pandemic strain*) was higher at 47.9% among healthcare workers when the WHO alert level was at phase 5 (Chor, Ngai et al. 2009). The majority of the workers in this study were nurses. Research in the UK carried out before the 2009 H1N1 pandemic, but at a time of high media coverage about an outbreak of H5N1 influenza, found that 58% of the 520 staff at a hospital said they would accept a pre-pandemic vaccine against this type of influenza (Pareek, Clark et al. 2009). The majority of the respondents were 'frontline' medical or nursing staff.

Intentions to be vaccinated against H1N1 influenza: health professionals

Rates of health care worker intention to be vaccinated against H1N1 influenza are highest in Mexico and Canada and lowest in Greece. Methodological issues may have influenced the results: for example, the studies vary in their size and the proportion of the health care population studied, and some have included primary and secondary care workers whereas others have only included secondary care workers.

A cross sectional study carried out between June and September 2009 of 1,097 health care workers (60% nurses and 40% doctors) from two hospitals in Mexico City found that 80% intended to accept the vaccine and 71% would recommend it to their patients. The proportion may be higher than in other studies because the outbreak of H1N1 originated in Mexico City (Esteves-Jaramillo, Omer et al. 2009). A Canadian study involving 214 family physicians and 714 paediatricians found that 77% and 88% respectively intended to be vaccinated against H1N1 influenza (Dube, Gilca et al. 2010). Another study of 4,046 Canadian health care workers (46% nurses), found that 69% intended to be vaccinated (Kaboli, Astrakianakis et al. 2010). Both these studies were carried out in August and September 2009 before negative publicity about the safety concerns around the vaccine had begun.

Lower rates of intention to be vaccinated have been found in studies carried out in Australia, France and Italy. An online questionnaire of 1,960 Italian hospital workers (87% nurses and 13% physicians) found that 30% of the women and 49% of the men intended to be vaccinated against H1N1. This study was carried out during October 2009 (La Torre, Di Thiene et al. 2009). A cross sectional telephone interview study carried out in September 2009 in France

when vaccination had just been made available to the GPs, found that 62% of 1,434 GPs reported an intention to be vaccinated against H1N1 (Schwarzinger, Verger et al. 2010). A randomly sampled general population study found that of the health care workers in the sample 55.6% of those who worked for the UK National Health Service (NHS) and 52.4% who were non-NHS workers intended to be vaccinated. This study was carried out in the month before the vaccination programme had started in the UK (Rubin, Potts et al. in press).

The lowest rates for intentions to be vaccinated amongst health care workers have been found in Greece. A large nationwide study of over 12,000 Greek primary and secondary care health workers found that only 21.8% intended to be vaccinated against H1N1 (Maltezou, Dedoukou et al. 2010). This study was carried out in October, the month before Greece entered the winter pandemic phase and before it had started its pandemic influenza vaccination campaign and so awareness of the need for vaccination may have been low.

Uptake of vaccination against H1N1 influenza: Health professionals

There are differences in uptake of vaccination by country of study, with Southern and parts of Eastern Europe having the lowest coverage in comparison with all other countries offering a vaccination programme. However, as can be seen from Table 1 some of these studies were carried out during the early stages of the country's vaccination programme and therefore there was less opportunity for people to have been vaccinated before the data were collected. The higher rates observed in the UK than in some other countries are found after the vaccination programme had been running for six months. The evidence shows that uptake of vaccination is generally lower than reported intention to be vaccinated against H1N1. However in studies of intentions which were carried out closer to when the vaccination programmes started and later in the course of the pandemic (see table 1) intentions were lower and thus the gap between intentions and uptake smaller.

In England up to March 2010 40% of health care workers had been vaccinated, in Northern Ireland the rate was 48% and in Scotland 55% (McClean and Peabody 2010). In the USA 37% of health care workers have been vaccinated (Centers for Disease Control and Prevention 2010).

Lower rates have been reported in studies from Spain, Italy and Turkey. Rates in Italy are reported as 14% of health professionals being vaccinated by November 2009 (La Torre, Di Thiene et al. 2009); however, this is only one month into the vaccination programme. In Spain a study carried out between December 2009 and January 2010 found that 16.5% of the workers had been vaccinated (Virseda, Restrepo et al. 2010). Operational factors may have affected the uptake in this study. It was carried out with a representative sample in one hospital where vaccination was only offered in 6 places, rather than on every ward as is the case for seasonal influenza (the uptake of which was higher). The lowest rate was observed in Turkey in a study carried out between November and December 2009, with 12.9% of 300 hospital workers (including doctors, nurses and allied health professionals e.g. physiotherapists) having been vaccinated (Savas and Tanriverdi 2010). The rate of uptake
observed in this study may have been caused by the mismatch between health authority recommendations (encouraging vaccination) and negative publicity, both from media reporting and from the Turkish Prime Minister stating that he was against the vaccination programme.

The preliminary findings from the VENICE-ECDC study (collected in August 2010) show Hungary as having the highest reported coverage in health professionals at 70%, followed by Romania and the Netherlands at just over 50%. Italy and Spain have rates of approximately 15% and 12% respectively, in line with the smaller studies reported above, and the Czech Republic reported rates of less than 10% (Mereckiene 2010). It is notable that these low rates in Italy and Spain are when their vaccination programmes had been running for 10 months, indicating that perhaps lack of time to be vaccinated is not the cause of the low rates observed in the earlier studies.

Vaccination uptake and intentions amongst the general population

Whilst data are available for uptake rates for targeted clinical risk groups, pregnant women, children and the general population, the studies of intention do not distinguish between these groups.

Intentions to have a pre-pandemic vaccination: general population

A study of 508 members of the general population carried out in the Netherlands in April 2009 before the discovery of the first cases of H1N1 influenza found that 66% would take a pre-

pandemic vaccination before an outbreak and 95% would take a vaccination during an outbreak (Zijtregtop, Wilschut et al. 2009). These high rates are in stark contrast to most other studies where intention has been assessed during an outbreak. The high rates may be explained by the fact that the Netherlands has the highest uptake in Europe for seasonal influenza vaccination and therefore the population is used to such vaccinations for influenza.

Intentions to be vaccinated against H1N1 influenza: general population

General population rates of intention to be vaccinated showed less variation than health professional rates. They were generally between 40% and 70%, with the lowest rates being observed in Southern Europe and the highest rates in the USA, Australia and Malaysia. Whilst around half of the population intended to be vaccinated this dropped dramatically if there was a concern about safety or if payment was required.

A cross sectional interview study of 627 respondents in Australia carried out in September and October 2009 found that 54% would accept the vaccine for H1N1, even though the majority of respondents thought that they were at low risk of developing swine flu (Seale, Heywood et al. 2010). A larger Australian study carried out in August 2009 found that 67% of 1155 adults reported that they were likely to accept the pandemic flu vaccine (Eastwood, Durrheim et al. 2010).

A study of 2,067 American adults surveyed during May and June 2009 at the beginning of the pandemic found that only 49.6% intended to be vaccinated against H1N1 despite concern about becoming ill with H1N1 influenza being high (Maurer, Harris et al. 2009). A later cross-sectional study of 210 people carried out in August 2009 in the USA found that 64% intended to be vaccinated against H1N1 (Horney, Moore et al. 2010). A telephone survey study carried out in the UK during August- September 2009 (i.e. before vaccination was available) found that 56% of randomly sampled general population reported that they were likely to have the vaccination if offered it (Rubin, Potts et al. 2010). A multi-ethnic sample of Asian respondents in Malaysia found that 70% intended to be vaccinated (Wong and Sam 2010).

Sixty percent of a representative sample of 1,001 members of the general French population reported an intention to be vaccinated in June 2009 (Setbon and Raude 2010). In contrast, a cross sectional internet survey of 2,253 French adults carried out in November 2009

(Schwarzinger, Flicoteaux et al. 2010) found that only 15% of the respondents intended to be vaccinated (despite vaccination being available to them). The difference may have been due to the relative anonymity of the data collection methods – one where the respondent spoke to an interviewer with the potential for social pressure to report an intention to 'do the right thing', i.e. be vaccinated, and the other which was online. In addition, there may be selection bias with the internet sample where more individuals with negative attitudes towards vaccination took part.

The influence of concerns about safety or financial considerations on intention levels can be seen in three studies. An internet survey carried out in the USA during 2009 with 1543 adults (Quinn, Kumar et al. 2009) found that only 8.7% of respondents reported that they would accept a new but yet to be approved vaccine against H1N1. A cross sectional study in Hong Kong found that whilst 45% (n=135) of the participants reported that they would be highly likely to take up vaccination if it was free, this percentage reduced to 15% if it cost more than $HK200. In the absence of proven efficacy and safety of the vaccine only 5% (n=14) would be vaccinated (Lau, Yeung et al. 2010). A weekly telephone interview study of 1,000 people in Greece found that in August, before negative publicity about vaccine safety had begun, 53% of individuals intended to be vaccinated; however by the end of the study in October 2009 this had dropped to 37% (Sypsa, Livanios et al. 2009).

Uptake of vaccination against H1N1 influenza: clinical risk groups, pregnant women and the general population

Uptake of vaccination against H1N1 amongst at risk groups, pregnant women and the general population is sub-optimal with most countries reporting uptake levels of less than half of the target population. As with health professionals, generally the rates of uptake of vaccination are lower than reported intentions. It is problematic to make absolute comparisons between countries as they will have differed in how strongly vaccination was recommended and encouraged and this will inevitably have affected uptake rates.

Clinical risk groups

In the UK vaccination against H1N1 was offered to selected at risk groups, with uptake rates in March 2010 (and June 2010 in Wales) of 37.6% in England, 42.1% in Wales, 52.1%-54.5% in Scotland and 86.5% in Northern Ireland (McClean and Peabody 2010). A study carried out in

France in November 2009 found that 34.8% of individuals with chronic disease had been vaccinated (Schwarzinger, Flicoteaux et al. 2010).

Preliminary findings from the VENICE-ECDC study shows variation amongst EU countries. Approximately 75% of risk groups in the Netherlands have been vaccinated, whereas in Spain, Estonia and Denmark the rate is just over 20%, in Italy about 12% and in Luxemburg about 8% (Mereckiene 2010).

In the USA 25% of individuals in high risk groups due to underlying medical conditions had been vaccinated by January 2010 (Centers for Disease Control and Prevention 2010).

Pregnant women

In Northern Ireland 57.1% of pregnant women were vaccinated by March 2010 (McClean and Peabody 2010). In France a study carried out in November 2009 found that 37.9% of pregnant women had been vaccinated (Schwarzinger, Flicoteaux et al. 2010).

Preliminary findings from the VENICE-ECDC study show marked variation in coverage of vaccination for pregnant women in the EU. In the Netherlands nearly 60% of pregnant women were vaccinated, whereas in Italy rates are approximately 12% and in Spain, Hungary, Estonia, Slovenia and the Czech Republic rates are less than 10% (Mereckiene 2010).

General population

In France a study found that only 1.9% of 2,253 people had been vaccinated by November 2009, one week before the peak of the pandemic in France (Schwarzinger, Flicoteaux et al. 2010). The study authors suggest that this low rate may partly be explained by the decision to have vaccination carried out in large centres specifically set up for the purpose rather than involving primary care doctors in the programme (as is the case in the UK for example). This points to the importance of easy accessibility for promoting vaccine uptake. In addition, there was a mismatch between alarming public health messages about the severity of the pandemic which were at odds with personal experience of a relatively mild disease.

Preliminary findings from the VENICE-ECDC study show marked differences in population coverage amongst EU and EEA countries. From the highest coverage rates in Sweden (60% vaccinated), Finland, Iceland and Norway (around 50% vaccinated) to rates of less than 10%

in a number of other countries (Germany, France, Luxembourg, Portugal, Slovenia, Italy, Estonia, Greece, Cyprus, Austria and the Czech Republic) (Mereckiene 2010).

There is some evidence of a major practical problem which might have affected coverage in countries where there is an entrenched individual doctor-patient relationship (e.g. France and Belgium). In these countries the multi-dose vial containing the vaccine was an issue as GPs were reluctant to purchase and open a vial which contained 10 doses of vaccine for just one patient and then have to throw this away or store it unsafely (Prof Angus Nicoll, personal communication). In addition, in some countries the government did not gain the support of their GPs in administering the vaccination programme. For example, whilst in the Netherlands and parts of Sweden and Norway vaccinating in Centres which were specifically set up for the purpose worked well for the general population, this was not the case in other countries such as France (Prof Angus Nicoll, personal communication).

The US Centers for Disease Control and Prevention found that the median percentage of adults having been vaccinated in the USA up to January 2010 was 20% (Centers for Disease Control and Prevention 2010). There were age differences within this, with 22% of over 65 year olds being vaccinated in comparison with 14% of people aged 25-65 years old. A further study carried out in March 2010 involving a representative sample of 3,917 American adults also found that only 20% had been vaccinated against H1N1 influenza (Maurer, Uscher-Pines et al. 2010). A study carried out during November and December 2009 involving 10,231 households in Australia found that 19% of adults had been vaccinated. As for the USA figures, there were differences for age in this with 42% of adults over 65 having been vaccinated in comparison with only 14% of adults under 65 years old (Australian Institute of Health and Welfare 2010).

Uptake of, and intentions towards, vaccination for children

There is less extensive research examining parents' intentions to have their children vaccinated against H1N1 influenza, or their uptake of invitations to have their children vaccinated.

Intentions to have children vaccinated against H1N1 influenza

A study carried out in France in June 2009 with a representative sample of 1,001 individuals found 65% of parents reporting that they would have their children vaccinated (Setbon and Raude 2010). Similar rates were found in a UK sample of health care workers with 60% of NHS staff reporting that they would be willing to have their children vaccinated and 75% of non-NHS workers stating that they would be (Rubin, Potts et al. in press). However, a later internet survey of a representative sample of 2,253 French adults carried out in November 2009 found that only 21% of parents were willing to get their children vaccinated (Schwarzinger, Flicoteaux et al. 2010).

Uptake of vaccination against H1N1 influenza for children

Rates of vaccination of children show some variation across countries. In England and Wales only 23.6% and 26.1% of children under 5 have been vaccinated; the rates in Northern Ireland and Scotland are slightly higher (38.3% and 44.6% respectively) (McClean and Peabody 2010). Preliminary findings from the VENICE-ECDC study show that vaccination coverage of children in the Netherlands is nearly 80%, in Norway nearly 60%, and in Ireland and Iceland nearly 50%. In contrast, rates in Luxembourg, Slovenia and Italy are all below 10% (Mereckiene 2010).

In the USA by January 2010 37% of children had been vaccinated (Centers for Disease Control and Prevention 2010). However, there was wide variation amongst States with the coverage ranging from 21% (in Georgia) to 84% (in Rhode Island).

Conclusions regarding vaccination uptake and intentions

- Intentions towards vaccination uptake and uptake are similar in health professionals and the general public.
- Sixty five to eighty percent of the population intended to be vaccinated across most countries in the early stages of the pandemic, reducing towards the later stages as the relatively ‘mild’ nature of the pandemic became apparent.

- Less than ten percent to eighty percent of the population were vaccinated, with the highest uptake rates in the Netherlands, Scandinavian countries, UK and USA and lowest rates in Southern Europe and some Eastern European countries.
- Intentions to be vaccinated are higher than actual uptake but this gap is less in studies measuring intention closer to the start of the vaccination campaigns and in the later stages of the pandemic.

Factors associated with intentions and uptake of vaccination

Described below are factors associated with vaccination intentions and uptake. It will be seen that these are similar for health professionals and the general population and include: a lack of perceived susceptibility to influenza, a low perceived threat of the disease, and concerns about the safety of the vaccine. Whilst most studies lacked an explicit theoretical framework, these findings can be broadly explained by theories of health behaviour which provide explanatory models of how people react to a threat to their health, such as the health belief model (HBM), theory of planned behaviour (TPB), protective motivation theory (PMT) and the common sense model of illness (see Appendix 3 for more detail of these theories).

A recently published European Union study of EU wide pandemic vaccine strategies amongst 23 member states found that nearly all of the respondents reported difficulties in meeting their national vaccination goals. The main reasons for these shortfalls were attributed to scepticism and/or limited interest on behalf of the health care workers and the general population. Other significant factors included the moderate character of the pandemic and the safety concerns of the H1N1 influenza vaccines (Health Protection Agency & Crismart 2010).

Health Professionals

Demographic factors

Studies in Greece and Canada have found that older health care workers are more likely to intend to be vaccinated against H1N1 influenza (Kaboli, Astrakianakis et al. 2010; Maltezou, Dedoukou et al. 2010) and male health workers are more likely to intend to be vaccinated (La Torre, Di Thiene et al. 2009; Kaboli, Astrakianakis et al. 2010; Maltezou, Dedoukou et al. 2010). Studies from Italy, Spain and Canada have found that doctors are more likely to intend

to be vaccinated and be vaccinated than nurses (La Torre, Di Thiene et al. 2009; Kaboli, Astrakianakis et al. 2010; Virseda, Restrepo et al. 2010). There was some evidence from these studies that there was a higher level of knowledge amongst doctors about the risks posed by H1N1 and that this may have influenced their decisions.

Attitudinal factors

Perceptions of risk

Perceptions of the risk posed by pandemic flu have been found to be associated with intentions and behaviour. Studies in, Greece, Spain and the UK have found that perceptions of not being at risk from swine flu or having a lack of concern about it are associated with reduced intentions to be vaccinated (Maltezou, Dedoukou et al. 2010) and lack of uptake (Virseda, Restrepo et al. 2010). A belief that the risk of pandemic flu is high is associated with intentions to have a pre-pandemic vaccine (Pareek, Clark et al. 2009) and worry about catching H1N1 influenza or one's child catching it has been found to be associated with greater intentions to be vaccinated against H1N1 in a UK study (Rubin, Potts et al. in press)

Perceived severity of the pandemic

A perception that a pandemic would have severe consequences has been found to be associated with intentions to have a pre-pandemic vaccine (Pareek, Clark et al. 2009), whereas studies from Canada have found that a perception that the pandemic is mild and does not pose a threat is associated with less intention to undergo vaccination (Dube, Gilca et al. 2010; Kaboli, Astrakianakis et al. 2010).

Perceived efficacy of vaccine

Evidence from studies carried out in the UK, Spain and Hong Kong shows that a wish to protect oneself or others and a belief in the efficacy and safety of the vaccination is associated with intentions to have a pre-pandemic vaccine (Chor, Ngai et al. 2009; Pareek, Clark et al. 2009), intentions to be vaccinated against H1N1 (Esteves-Jaramillo, Omer et al. 2009; Dube, Gilca et al. 2010) and uptake (Virseda, Restrepo et al. 2010). In addition a belief that the vaccine does not work is associated with less intention to be vaccinated (Rubin, Potts et al. in press).

Perceived barriers to having the vaccine

Fear of the side effects of the vaccine, concerns about its safety and doubts about the adequacy of clinical trials have been found to be associated with a lack of intention to have a pre-pandemic vaccination (Pareek, Clark et al. 2009) a lack of intention be vaccinated against H1N1 (Dube, Gilca et al. 2010; Kaboli, Astrakianakis et al. 2010; Maltezou, Dedoukou et al. 2010; Rubin, Potts et al. 2010) and uptake of vaccination (Virseda, Restrepo et al. 2010) in studies carried out in the UK, Greece, Spain and Canada.

Anxiety

Only one study (Savas and Tanriverdi 2010) specifically examined the influence of levels of general anxiety on intentions to be vaccinated against H1N1 influenza, finding that in Turkey, those who did not intend to be vaccinated were those with the highest levels of anxiety and were most likely to believe that the vaccination was unsafe.

Past behaviour

Studies carried out in the UK, France, Greece, Spain and Hong Kong have found that having had a seasonal flu vaccine in the past is a significant predictor of intentions to undergo a pre-pandemic (Chor, Ngai et al. 2009; Pareek, Clark et al. 2009) and a pandemic vaccine (Maltezou, Dedoukou et al. 2010; Schwarzinger, Verger et al. 2010; Rubin, Potts et al. in press) and of uptake (Virseda, Restrepo et al. 2010).

General Population

The evidence available for factors affecting uptake of vaccination does not distinguish between clinical risk groups or the general population.

Demographic factors

Age

Studies in the UK, France and the USA have found an effect of age on intentions to be vaccinated, with two studies finding that older people are more likely to intend to be vaccinated (Maurer, Harris et al. 2009; Schwarzinger, Flicoteaux et al. 2010) and one that younger people

are (Rubin, Potts et al. 2010). However, one study in the USA found no influence of age on intentions to have a vaccination (Quinn, Kumar et al. 2009).

There is also an effect of age on uptake of vaccination. As described above data from the USA and Australia show that those over 65 are more likely to have been vaccinated than younger people (Australian Institute of Health and Welfare 2010; Centers for Disease Control and Prevention 2010).

Gender

Men in France, Greece and the Netherlands have been found to be more likely than women to accept a pre-pandemic vaccine (Zijtregtop, Wilschut et al. 2009) or to intend to be vaccinated (Sypsa, Livanios et al. 2009; Schwarzinger, Flicoteaux et al. 2010). No gender differences were found in intentions to be vaccinated in one study (Quinn, Kumar et al. 2009).

Ethnicity

People from ethnic minorities are more likely to intend to be vaccinated (Quinn, Kumar et al. 2009; Rubin, Potts et al. 2010; Seale, Heywood et al. 2010). This finding may be explained by data from the UK which shows that people from Asian ethnic minorities are more likely to be hospitalised with H1N1 influenza (Nguyen-Van-Tam, Openshaw et al. 2010). In addition other research from the UK finds that mortality rates amongst children from H1N1 influenza were higher for Bangladeshi children and Pakistani children than for white British children (Sachedina and Donaldson 2010).

Attitudinal factors

Perceived risk

Studies in the UK, USA, Australia, France, Greece and the Netherlands have found that intentions to be vaccinated are associated with concern about contracting swine flu or about one's child catching it, feelings of being at risk or vulnerable, and levels of worry about H1N1 influenza (Quinn, Kumar et al. 2009; Sypsa, Livanios et al. 2009; Zijtregtop, Wilschut et al. 2009; Horney, Moore et al. 2010; Rubin, Potts et al. 2010; Schwarzinger, Flicoteaux et al. 2010; Seale, Heywood et al. 2010; Setbon and Raude 2010). Also feelings of worry about swine flu have been found to be associated with intending to have one's children vaccinated (Setbon and Raude 2010).

Perceived severity of pandemic

Evidence from Greece and Australia has shown that a belief that swine flu is severe is associated with intentions to be vaccinated (Sypsa, Livanios et al. 2009; Eastwood, Durrheim et al. 2010) or to allow one's children to be vaccinated (Schwarzinger, Flicoteaux et al. 2010). Studies carried out in the UK, USA and Australia have found that a belief that H1N1 influenza is a mild disease or that too much fuss has been made about the pandemic is associated with reduced intentions to be vaccinated (Horney, Moore et al. 2010; Rubin, Potts et al. 2010; Seale, Heywood et al. 2010).

Perceived efficacy of vaccination

One study carried out in the Netherlands found that a belief that a pre-pandemic vaccine would be effective was associated with intentions to be vaccinated (Zijtregtop, Wilschut et al. 2009). Studies in Australia and Malaysia have found that individuals were motivated to be vaccinated by the personal protection they felt the vaccination would give them (Seale, Heywood et al. 2010; Wong and Sam 2010).

Perceived barriers to vaccination

Studies from Australia, France, Hong Kong, Greece and the USA have found that concerns about safety and fear of side effects of the vaccination is associated with a reduced intention to have it (Sypsa, Livanios et al. 2009; Horney, Moore et al. 2010; Lau, Yeung et al. 2010; Schwarzinger, Flicoteaux et al. 2010; Seale, Heywood et al. 2010). A study in Malaysia found that for Malay respondents (who were predominantly Muslim) fearing that the vaccine was not an Halal vaccine (as it might contain porcine elements) was associated with reduced intentions to be vaccinated, whereas Chinese and Indian respondents were more motivated by safety concerns about the vaccine (Wong and Sam 2010).

Cues to action/Social pressure

Studies from the Netherlands and Hong Kong have found that a belief that others would want you to be vaccinated or that family and friends have been vaccinated is associated with intentions to have a vaccination against H1N1 (Zijtregtop, Wilschut et al. 2009; Lau, Yeung et al. 2010) or a pre-pandemic vaccination (Zijtregtop, Wilschut et al. 2009). A study in France showed that being advised by a health care worker to be vaccinated was associated with intentions to do so (Schwarzinger, Flicoteaux et al. 2010).

Trust in Government

A UK study found that those who felt the government were handling the pandemic crisis well and were well prepared were more likely to intend to be vaccinated (Rubin, Potts et al. 2010). A study from the USA found that trust in the government was a predictor of intention to have a pandemic vaccine that had not yet been approved (Quinn, Kumar et al. 2009). There is evidence of good uptake of vaccination in countries where there seems to be good trust in the government or technical bodies e.g. Canada, Denmark, Finland, the Netherlands, Norway and Sweden (Prof Angus Nicoll, personal communication).

Past behaviour

Several studies from Australia, USA, France and the Netherlands found that having previously been vaccinated against seasonal flu was associated with a greater intention to have a vaccination against H1N1 influenza (Quinn, Kumar et al. 2009; Zijtregtop, Wilschut et al. 2009; Eastwood, Durrheim et al. 2010; Horney, Moore et al. 2010; Maurer, Uscher-Pines et al. 2010; Seale, Heywood et al. 2010; Setbon and Raude 2010). This may be because regular users of the seasonal vaccine were significantly more likely to consider H1N1 influenza to be a serious disease and were twice as likely as irregular or non-users of the seasonal vaccine to hold positive attitudes about the safety and value of vaccination (Maurer, Uscher-Pines et al. 2010).

Conclusions about factors associated with uptake and intentions

The evidence suggests that low perceived susceptibility to swine flu and low perceived severity of the swine flu pandemic, together with concerns about the safety of the vaccine and being unconvinced of its efficacy have led to low levels of uptake of vaccination against H1N1 amongst the general population and health professionals. The evidence also shows that past behaviour is important in that having been vaccinated against seasonal influenza is strongly associated with intentions and uptake of vaccination against pandemic influenza. Given the mild nature of the disease, rather than having to contend with panic and raised concerns about the pandemic, the problem was convincing people that the disease posed a real threat and that vaccination can help to ameliorate the risk. If the pandemic had been more deadly than it turned out to be it is likely that vaccination rates would have been higher (Harris, Maurer et al. 2010).

Interventions and communication strategies to increase informed uptake of vaccination against H1N1

The vaccination programmes were set up aiming for 100% uptake either amongst specified risk groups or amongst the general population. The aim of a public health intervention such as vaccination against pandemic influenza should be to promote informed uptake amongst health professionals and members of the general public; this may mean that individuals make an informed choice *not to be vaccinated*. High uptake is particularly important if a vaccine programme is ultimately aimed at the whole population in a bid to reduce transmission of disease and impact of a future pandemic, rather than to primarily protect the individual themselves (if they are not at increased risk of complications from pandemic influenza).

Informed decision-making is supported by information that is specific and directly relevant to the concerns of targeted groups. In making a decision people will weigh up the costs and benefits of both doing and not doing an action. To increase vaccination uptake, people need to be convinced that it is necessary in order to avoid a real and severe risk, as well as being persuaded of the effectiveness and safety of getting vaccinated. Given that some studies have found demographic differences in intentions to be vaccinated, communications will also need to be appropriately targeted.

Effective interventions need to target both motivational and volitional influences on behaviour (Scholz, Nagy et al. 2009). Motivational influences are those which affect the formation of an intention to act (e.g. perceptions of risk of H1N1 and beliefs about the efficacy and safety of being vaccinated). Volitional influences include aspects which will affect the translation of a reported intention into behaviour and involve action planning and action control. An example is making plans as to when, where and how the behaviour will be carried out (Sniehotta, Scholz et al. 2005).

It is also important to consider *modes* of delivery of communication (e.g. leaflets, blogs, internet sites etc.) and to ensure that the content of all of these is represented in the most effective way to maximise informed uptake. For example, research has shown that the use of natural frequencies as opposed to probability frames allows people to make better sense of risk information (Reyna and Brainerd 2008; Reyna, Nelson et al. 2009).

A recent assessment of the EU wide vaccine strategies asked member states what they would do differently in a future pandemic to improve communication with their target groups (Health Protection Agency & Crismart 2010). Some said that they would concentrate on communicating with healthcare workers and the media due to their influence on the general public. One country said that they would take into consideration an observed greater level of anxiety amongst ethnic minority groups. A further two countries also commented on the need to target specific groups which might be hard to reach or reassure. One of these countries suggested specifically targeting more mothers of school children as the mother is the most likely member to convince the remainder of the family to take up the vaccine. One country stated that it would be important to launch specific pandemic vaccination campaigns to counteract negative publicity. None mentioned the use of behavioural science specialists in developing their communication campaigns or the use of evidence from behavioural science to inform the content or delivery of their campaigns.

Interventions to increase the uptake of seasonal influenza vaccination

The evidence from this review suggests that if rates of seasonal influenza vaccination are high then rates of pandemic influenza vaccination will also be high. For example the Netherlands has some of the highest rates of pandemic influenza vaccination and also very high rates of seasonal influenza vaccination. Interventions to increase seasonal influenza vaccination in advance of a future pandemic may be an effective strategy to achieve high rates of vaccination against influenza during a pandemic.

A systematic literature review identified 44 randomised controlled trials (RCTs) testing interventions to increase influenza vaccination rates among people over 60 years old (Thomas, Russell et al. 2010). The interventions included (a) increasing community demand by increasing perceptions of susceptibility to influenza, vaccine effectiveness, and reduce concern over side effects; (b) enhancing access by providing more clinics, vaccination during home visits and free vaccinations. In addition, provider or system based interventions, such as interventions with healthcare workers, included: a) changing beliefs and attitudes about the susceptibility of patients and themselves to influenza, and the effectiveness and safety of vaccination; b) strategies to increase motivation and willingness to vaccinate patients; and c) reminders to vaccinate patients. The review found that the strongest evidence of effectiveness

was for interventions that offered influenza vaccination during home visits to those ≥60, and use of facilitators in primary health care settings to encourage influenza vaccination.

A systematic review of interventions to increase vaccination amongst health care workers included 12 randomized controlled trials and controlled before-and-after studies which were published from 1992 to 2009 and were conducted in long-term care facilities, hospitals and primary health care settings (Lam, Chambers et al. 2010). The studies were based in the United States, Canada, the United Kingdom, Germany and Switzerland. Various types of campaigns and interventions were used, including: education or promotion (efforts to raise awareness and increase knowledge about influenza and vaccination); improved access to vaccination (e.g. extended opening hours, mobile vaccination); legislation or regulation (e.g. mandatory vaccination); measurement and feedback where rates are tracked and then publicised; role model work where senior staff encourage vaccination. The study found that in non-hospital health care settings, a combination of education or promotion and improved access to the vaccine yielded greatest increases in coverage. In hospital settings, education or promotion or improved access interventions resulted in only small improvements in coverage. Campaigns involving legislative or regulatory components achieved higher rates of coverage.

Neither review included studies carried out during the 2009 pandemic. The lack of evidence-based theory in developing or evaluating these interventions is a weakness. In order for studies to increase understanding as to how interventions work and, therefore, inform the development of more effective interventions, it is important to develop and evaluate them within a theoretical framework (Michie and Abraham 2004).

Communicating risk/Increasing levels of perceived risk

Meta-analyses have shown that perceptions of risk can be an important predictor of uptake of vaccination (Brewer, Chapman et al. 2007). Given the previous “mild” nature of the H1N1 influenza, there may be greater resistance to vaccination in a future pandemic; future communications should consider how best to achieve the desirable level of public’s perception of risk, and thus their willingness to be vaccinated. A caveat here is that there is evidence that interventions that increase perceived threat can be ineffective if they increase anxiety to such an extent that they lead the individual to denial or avoidance of the issue (Witte 1998;

Albaraccin, Gillette et al. 2005). In order to avoid this, messages about risk should be measured and combined with advice about how to manage this risk effectively (Witte and Allen 2000; Miller, Yardley et al. under review). In the context of vaccination this would involve providing messages about the safety and benefits of vaccination.

If a worst case scenario approach is taken, there is the possibility of a reduction in credibility of the risk communication if it fails to materialise. This can have an effect on future communications where fewer people will believe the message. Maintaining trust in communications over the longer term should take precedence over short term gains in uptake.

In situations where risk is low, it may be neither possible nor desirable to use communications about the objective level of risk as a tool to increase uptake. However, there are other ways in which uptake can be enhanced. For example, perceived risk phrased in terms of feelings rather than as a purely cognitive probability judgment can predict influenza vaccination behaviour (Weinstein, Kwitel et al. 2007). This study also found that anticipated regret at not being vaccinated was a strong predictor of behaviour. Providing communications nuanced towards highlighting such feelings may therefore be effective in encouraging uptake.
In communicating the risk to pregnant women of developing H1N1 influenza, the estimates of threat should be presented using *relative risk* (Han, Klein et al. 2009) and the rates of complications should be presented for both groups (pregnant and non-pregnant), using *natural frequencies (*Reyna and Brainerd 2008; Reyna, Nelson et al. 2009), as opposed to probability frames. This will make clear the absolute and relative risks of serious complications in different groups, and maximise the chances of informed choice regarding vaccination. Examples of this approach are “Pregnant women are four times as likely to develop complications from H1N1 influenza as non-pregnant women. Of 1,000 pregnant women *n* would develop complications whereas of 1,000 non-pregnant women *n* would develop complications”.

Highlighting the benefits/efficacy of vaccination

Individuals may be motivated to be vaccinated by a desire to protect themselves, or in a bid to minimise anxiety and worry. Campaigns should emphasize the need for high vaccination rates in order to encourage altruism where individuals will think that being vaccinated is important not just for them but also for others (Hershey 1994; Hershey, Asch et al. 1994).

There is evidence that if health care workers have to sign a form saying they have understood the benefits of vaccination but are still refusing to be vaccinated that this increases acceptance (Talbot et al 2009). This shows the usefulness of making the benefits of vaccination explicit.

For health professionals it will be important to stress the importance of vaccination for protecting their own health and also for the health of their patients as a lack of perceived efficacy of the vaccine can be a barrier to uptake. Research in other areas suggests that relatively simple information can change health professionals' perceptions of effectiveness of a treatment and lead to self-reported behaviour change (Vogt, Hall et al. 2009). It may therefore be possible to increase the chances of health professionals recommending the H1N1 vaccine by increasing their perceptions of the efficacy of it.

Estimates of effectiveness should be presented using natural frequencies to make transparent the absolute risk of a problem and the relative risk reduction of an intervention. For example one could state the number out of a group of 100 people expected to develop H1N1 influenza with and without the vaccination.

Tackling concerns about safety

In tackling concerns about safety it is important to engage with the media to make sure that reporting is unbiased as people give more weight to things that they can readily bring to mind - 'availability effect' (Tversky & Kahneman 1974). Therefore if adverse reactions to the vaccination are disproportionately reported in the media this may adversely affect uptake. An equal number of stories about good and bad aspects of vaccination will make it seem like they are equally likely even if the information in them is accurate and unbiased (Brown, Kroll et al. 2010). The implication is that it is important to publicise stories about the negative consequences of failing to be vaccinated (such as unnecessary morbidity and mortality).

The wider literature about reasoning processes in the light of health threats points to potentially effective strategies to increase uptake of vaccination for children. For example, research into uptake of immunisation for measles, mumps and rubella (MMR) suggests that one reason for non-uptake of vaccination for children is the influence of the 'omission bias'. This is the belief

that causing harm through action is less acceptable than causing harm through inaction (Spranca, Minsk et al. 1991). Such omission tendencies primarily result from people drawing a sharp distinction between direct and indirect causation: people think about harms caused by direct actions much more than harms caused only indirectly. In addition, research has shown that risks from natural causes (e.g. disease) are less concerning to individuals than equivalent risks from man-made causes (e.g. vaccines) (Slovic 1999). Parents deciding about vaccinating their children against MMR have been found to demonstrate an omission bias: 'even when parents believe the risks of immunising to be lower than the risks of not immunising, they tend to decide against MMR because their decision is so strongly influenced by the idea that harm resulting from giving the immunisations is less acceptable than harm resulting from not giving the immunisation' (i.e. the omission bias) (Wroe, Bhan et al. 2005).

This omission bias has been found in an experimental study of a hypothetical disease and vaccine (Brown, Kroll et al. 2010), in which participants would accept a higher risk of their child catching a disease than they would of their child reacting to a vaccine, would consider a number of symptoms/signs as less serious if they were caused by a disease than if they were caused by a vaccine reaction, and would regard as acceptable a longer duration of symptoms/signs as a consequence of disease than as a consequence of vaccine reaction.

In an intervention aimed at minimising this omission bias, undergraduate students were asked to read a 'debiasing' argument before putting themselves in the place of their hypothetical child and ask whether the child would prefer a greater or lesser chance of harm and whether it mattered to the child whether these chances came from someone's act or omission(Baron 1992). The study found that after reading this argument individuals tended to be more likely to decide to vaccinate. Using a debiasing argument of this kind with parents contemplating vaccination of their children against H1N1 influenza would only work if the risks in both cases (vaccination and non-vaccination) are known.

The omission bias can be lessened by getting the respondents to imagine themselves as doctors or medical directors making a decision for someone else (Zikmund-Fisher, Sarr et al. 2006) rather than for themselves. In this context individuals were more likely to choose the active harm minimising option (i.e. a vaccination that protects against flu but carries a 5%

chance of mortality) over the inactive harm maximising option (i.e. not being vaccinated against a flu virus that carries a 10% chance of mortality).

The omission bias can also be reduced by getting people to focus on immunisation as a social norm in order to encourage them to think about not immunising as an 'active' decision to deviate from this norm. This would have the result that the decision not to immunise becomes more of an act than the decision to immunise (Wroe et al 2005).

4. Conclusion

There are a number of strategies that may be effective for increasing uptake of vaccination. In advance of a future pandemic, efforts can be made to increase the coverage of seasonal influenza vaccination. Interventions likely to be effective include those which emphasise the risks of not being vaccinated both in terms of unnecessary morbidity and mortality and also in terms of experiencing feelings of regret and worry. The benefits of vaccination should be made explicit and safety concerns should be acknowledged and tackled by using interventions to reduce the omission bias.

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Table 2: Studies included in review showing associations between demographic, psychological variables and intentions or behaviour

Author & year	Study design & method & month of data collection	Type of vaccination	Country	Participants	Psychological Theory	Intentions or Behaviour	Results: Factors associated with behaviour or intention
Chor et al 2010	Cross sectional Questionnaire survey April 2009	Pre-pandemic H5N1 and H1N1	Hong Kong	N= 2,255 HCWs	None stated	Intentions	*Intention to be vaccinated associated with:* Higher perceived risk. Previous influenza vaccination
Dube et al 2010	Cross sectional questionnaire survey August-September 2009	H1N1	Canada	N=921 GPs and Paediatricians	None stated		*Intention to be vaccinated associated with:* a wish to protect oneself or others and a belief in the efficacy and safety of the vaccination *Intentions to not be vaccinated associated with:* a perception that the pandemic is mild and does not pose a threat and concerns about the vaccine's safety
Eastwood et al 2010	Cross sectional telephone interview August-	H1N1	Australia	N=1,155 general population	None stated	Intentions	*Intention to be vaccinated associated with:* Perceptions that

	September 2009						pandemic flu is serious. Previous influenza vaccination
Esteves-Jaramillo et al 2009	Cross sectional Questionnaire survey June 2009	H1N1	Mexico	N=1,097 HCWs	None stated	Intentions	*Intention to be vaccinated associated with:* Older age Higher perceived susceptibility, higher perceived severity, higher perceived benefits, lower perceived costs
Horney et al 2010	Cross sectional Interview survey August 2009	H1N1	USA	N=210 general population	None stated	Intentions	*Intention to be vaccinated associated with:* Concern about H1N1, previous flu vaccination. *Intention not to be vaccinated associated with:* Not feeling at risk, concern about side effects, belief that H1N1 is a mild disease
Kaboli et al 2010	Cross sectional online survey August-September 2009	H1N1	Canada	N=4,046 HCWs	None stated	Intention	*Intention to be vaccinated associated with:* being older, male, not a nurse, worry about making family ill. *Intentions not to be*

							vaccinated associated with: Lack of perceived severity of the pandemic and concerns about the safety of the vaccine
La Torre et al 2010	Cross sectional Online questionnaire	H1N1	Italy	N=1,960 HCWs	None stated	Intention & behaviour	Men and physicians more likely to be vaccinated
Lau et al 2010	Cross sectional Telephone interview July 2009	H1N1	Hong Kong	N=301, general population	Health Belief Model, Protection Motivation Theory	Intention	*Intention to be vaccinated associated with:* Perceptions of the side effects of the vaccination, friends and family having been vaccinated
Maltezou et al 2010	Cross sectional Questionnaire survey October 2009	H1N1	Greece	N=12,879 HCWs	None stated	Intention	*Intention to be vaccinated associated with:* Being male, older, having had seasonal influenza vaccination *Intentions not be vaccinated associated with:* Concerns about safety, perception of not being at risk, lack of information about vaccination
Maurer et al 2009	Cross sectional online questionnaire survey. May-June 2009	H1N1 & seasonal influenza	USA	N=2,067 general population	None stated	Intentions	*Intention to be vaccinated associated with:* Being older

Maurer et al 2010	Cross sectional online questionnaire survey. March 2010	H1N1 & seasonal influenza	USA	N=3,917 general population	None stated	Uptake of vaccination	*Intention to be vaccinated associated with:* Past seasonal influenza vaccination
Pareek et al 2009	Cross sectional questionnaire. February 2007	H5N1 pre-pandemic vaccine	UK	N=520, HCWs	None stated	Intentions	*Intention to be vaccinated associated with:* Previous seasonal influenza vaccination. Belief that vaccine would benefit self or hospital, belief that risk of pandemic flu is high. *Intention not to be vaccinated associated with:* lack of perceived severity of pandemic influenza and concerns about safety of the vaccine.
Quinn et al 2009	Cross sectional internet survey June-July 2009	H1N1 unlicensed vaccine	USA	N=1,543 general population	Health Belief Model	Intentions	*Intention to be vaccinated associated with:* Previous seasonal flu vaccine. Perceived susceptibility to H1N1. Being Hispanic (as opposed to white or black) *Intentions not be vaccinated*

							associated with: More worry about safety of the vaccine
Rubin et al 2010	Cross sectional telephone interviews May-September 2009	H1N1	UK	N=5,175, general population	None stated	Intentions	*Intention to be vaccinated associated with:* being younger, from an ethnic minority, being very worried about self or child, disagreeing that too much fuss has been made about swine flu, feeling government well prepared, satisfaction with the amount of information available about swine flu
Rubin et al, in press	Cross sectional telephone interviews September-October 2009	H1N1	UK	N=3,129 NHS and non-NHS workers	None stated	Intentions	*Intentions not to be vaccinated associated with:* feeling of not being at risk, low perceived benefits of the vaccine, safety concerns, concerns that the vaccine does not work *Intentions to have children vaccinated associated with:* worry about catching H1N1 or ones child catching it, having had previous

							seasonal flu vaccination
Savas et al 2010	Cross sectional questionnaire study November-December 2009	H1N1	Turkey	N=300, HCWs	None stated	Behaviour	*Intentions not to be vaccinated associated with:* higher state anxiety, a belief that the vaccine is not safe, nor protective,
Schwarzinger et al 2010	Cross sectional telephone interview September 2009	H1N1	France	N=1,434 GPs	None stated	Intentions	*Intention to be vaccinated associated with:* Past seasonal flu vaccination.
Schwarzinger et al 2010	Cross sectional online survey November 2009	H1N1	France	N=2,253 general population (including parents)	None stated	Intentions	*Intention to be vaccinated associated with:* being male, older. Past seasonal flu vaccine. Being advised by health care worker. *Intentions not to be vaccinated associated with:* Concerns about safety of vaccination *Intentions to have children vaccinated is associated with:* Believing that pandemic influenza is severe and feeling at risk from it
Seale et al 2010	Cross sectional interview.	H1N1	Australia	N=627, general population	None stated	Intention	*Intention to be vaccinated*

	September-October 2009						*associated with:* Perceived benefit of vaccination in terms of the protection afforded by it. Being non-Caucasian. *Intentions not to be vaccinated associated with:* Concerns about safety and side effects, perceived lack of susceptibility, perceived lack of severity of pandemic flu
Setbon & Raude 2010	Cross sectional telephone interview June 2009	H1N1	France	N=1,001 general population (including parents)	Self regulation model, Health belief model, illness perceptions	Intentions	*Intention to be vaccinated associated with:* Worry about pandemic flu, having a higher perceived risk of developing pandemic flu and previous seasonal flu vaccination. *Intentions to have children vaccinated associated with:* Feeling worried about pandemic flu and previous seasonal flu vaccination
Sypsa et al 2009	Cross sectional telephone survey	H1N1	Greece	N=1,000 general population	None stated	Intentions	*Intention to be vaccinated*

	August-October 2009						*associated with:* being male, older, feeling at risk from pandemic flu, believing it to be serious, having had previous seasonal flu vaccine. *Intentions not be vaccinated associated with:* concerns about safety of the vaccine
Virseda et al 2010	Cross sectional questionnaire survey. December 2009-January 2010	H1N1 & Seasonal influenza	Spain	N=527, HCWs	None stated	Behaviour	*Intention to be vaccinated associated with:* Being male, wanting to protect self and patients, being a member of a priority group for vaccination, having previous seasonal flu vaccine. *Intention not to be vaccinated associated with:* doubts about efficacy of vaccine, fear of side effects, and lack of concern about pandemic flu.
Wong and Sam 2010	Cross sectional telephone interview October-	H1N1	Malaysia	N=1,025, general population	None stated	Intentions	*Intention to be vaccinated associated with:* a belief that the

	December 2009						vaccine will offer protection, does not have side effects and is safe. Halal vaccine important for Muslims.
Zijtregtop et al 2009	Cross sectional questionnaire survey April 2009 (pre-pandemic)	Pre-pandemic vaccine (H5N1 and H1N1)	Netherlands	N=508, general population	Health Belief Model	Intentions	*Intention to be vaccinated associated with:* being male, fewer educational qualifications, low perception of susceptibility to pandemic flu and low perceived severity of pandemic flu, belief in the efficacy of vaccination, the influence of others Having had previous seasonal influenza vaccination.

Appendix 1: Search terms

Web of Science and PubMed were searched using the following terms:

Uptake vaccin* pandemic
Intervention vaccin* pandemic
Pre-pandemic vaccin*
Attitudes vaccin* pandemic
Multiple dose vaccin* pandemic
Emotion vaccin* pandemic
Anxiety vaccin* pandemic
Belief vaccin* pandemic
Uptake vaccin* influenza
Uptake vaccin* H1N1
Uptake vaccin* H5N1
Intention vaccin* influenza
Intention vaccin* H1N1
Intention vaccin* H5N1
Intention vaccin* pandemic
Vaccin* pandemic
Intervention vaccin* influenza

Appendix 2: Countries in which vaccination programme began

September 2009
China, Oman, Australia, Hungary

October 2009
USA, Belgium, Italy, Sweden, Finland, France, Japan, Monaco, Norway, UK, Austria, Canada, Germany, Kuwait, Luxembourg, Portugal, Korea, Slovenia

November 2009
Denmark, Ireland, Israel, Qatar, Saudi Arabia, Singapore, Turkey, Netherlands, Russian Federation, Switzerland, UAE, Greece, Jordan, Spain, Croatia, Cyprus, Romania

December 2009
Albania, Former Yugoslav Republic of Macedonia, Iran, Montenegro, Serbia

Source: WHO, Geneva

Appendix 3: Theories of Health Behaviour

The Health Belief Model

The HBM has been applied in a number of contexts including use of preventive screening, obtaining immunizations, compliance with medical regimens, and response to illness symptoms (see Sheeran & Abraham, 1996, for a review; Harrison, Mullen, & Green, 1992, for a meta-analysis). The HBM includes assessments of perceived susceptibility to, and severity of, a disease; and perceived benefits and perceived costs of a preventive health action and also cues to action.

The Theory of Planned Behaviour (TPB)

The TPB, an expansion of the theory of reasoned action which was devised by Fishbein and Ajzen (1975) to explain social behaviour, has been widely applied to a variety of behaviours – both health and non-health related (see Conner & Sparks, 1996, for a review and meta-analyses by Godin & Kok, 1996 and Sheppard, Hartwick, & Warshaw, 1988). The TPB postulates that the proximal determinant of a behaviour is an intention to perform it. In turn, intentions are determined by three constructs: attitude towards the behaviour, subjective norm, and perceived behavioural control (PBC).

Attitude towards the behaviour refers to the person's overall evaluation of the behaviour, which may be positive or negative. Subjective norms involve perceptions of how other people think the individual should behave in relation to the particular behaviour in question and also how these other people themselves behave. PBC aims to take account of differences in abilities, skills, access to resources, confidence, etc. between individuals.

Protection Motivation Theory

PMT (Rogers, 1975, 1983) was originally developed to understand the basis of fear appeals in health promotion. Protection motivation (a behavioural intention to perform a maladaptive or adaptive behaviour) is postulated to be determined by two processes: threat and coping appraisals. Threat appraisal involves a consideration of the severity of the health threat and a perception of personal vulnerability to it. Coping appraisal involves a consideration of whether

or not the health action is an effective means of alleviating the threat (i.e., response efficacy), and also a consideration by the individual of whether they will be able to carry out the health action (i.e., their perceived self-efficacy). PMT suggests that threat appraisal will generate an intention to act whereas coping appraisal will determine the type of action. This can be adaptive (i.e., in line with recommended behaviour) or maladaptive (i.e., against the recommendations). Rogers suggests that protection motivation is a linear function of the belief that the threat is severe, high personal vulnerability, a belief that one can perform the coping response and that the response is effective. It is a negative linear function of the reinforcements associated with the maladaptive response and of the response costs. A criticism of the above theories of behaviour is that they do not explain behaviours that are emotionally rather than cognitively and rationally driven as they do not adequately take into account emotional factors in decision making (Joffe, 1996).

The common sense model of illness

This was developed by Leventhal, Meyer, and Nerenz (1980) is a ‘parallel processing model’ whereby individuals simultaneously make cognitive and emotional representations of an illness. When faced with a new threat, individuals build a mental model of the threat in order to make sense of and manage the problem. The representation involves beliefs about the cause, consequences (in terms of the impact the disease would have), identity, time line, and controllability of the illness (Petrie & Weinman, 1997, 2006). A parallel emotional reaction interacts with this mental model and drives coping strategies and health behaviours relating to that threat. A meta-analysis including 45 studies examined the relationship between illness representations and coping and illness outcomes. This demonstrated how the relationships between these concepts were consistent with those predicted by the model and that the model predicted a variety of health behaviours (Hagger & Orbell, 2003).